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Humanizing the Kitchen Environment

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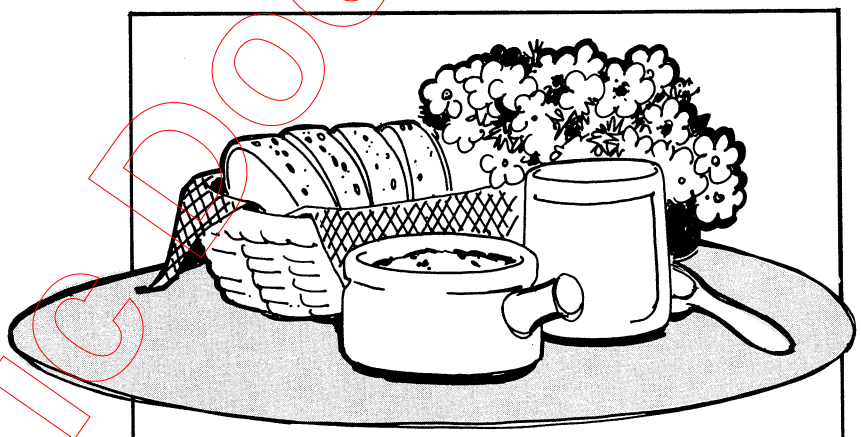

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The food service industry has concentrated in recent years on increasing the productivity of its workers. Administration and personnel management have helped. Use of convenience and ready foods, and of mechanized and automated equipment, has promoted phenomenal growth in the industry. Yet the amount of saleable product turned out per worker has remained low.

Human engineering may offer some solutions.

Also known as ergonomics, human engineering is, simply, "adapting human tasks and working environment to the sensory, perceptual, mental, and physical attributes of the human being." Man works well with good tools, placed effectively, in pleasant surroundings.

Great strides have already been made in other fields. Work space has been designed for the professional pilot to increase his abilities to control and land the sky giants. Submarine design aids the submariner to maintain skills over long periods of submergence.

There is no reason why the food service worker should not do his job as efficiently over long periods if his work areas are improved and the conditions which lead human beings to make errors are eliminated.

Tensions that produce fatigue also cause errors and low productivity. Fatigue shows in many ways:

- Decreased attention
- Slowed and impaired perception
- Impaired thinking
- Decreased motivation
- Decreased performance
- Increased number and length of pauses
- Sore and aching muscles

Some causes or situations producing fatigue and low productivity are:

- High temperature and/or humidity. Workers may work just as hard as under good conditions but pause more often and for longer periods. They might refuse to follow recipes, perhaps work sloppily, and are more accident prone.
- Available light level too low for task, glares in eyes, contrasts work and background too little or too much, or shows food and skin in unnatural colors.
- High noise impact, continual or repeated, causes body to tense and tire.
- Long periods of mental or manual work, where body is stooped or held in a confined or uncomfortable position. This happens most often in work at a table or desk that is too low or too high. Muscles tense to hold the body in an unnatural position.
- A standing position lasting too long (work as counterman or in a kitchen without stools or chairs).
- Repeated major body shifts (loading or unloading dishwasher from locations somewhat removed from machine).
- Insufficient knowledge or experience for the task (repairing dishwasher or preparing an unfamiliar recipe).
- Heavy physical exertion (scrubbing floor).
- Work at a disliked job (cleaning garbage cans).
- Work requiring careful attention to detail (payroll).
- Rush to meet deadlines (getting ready for service when understaffed).
- Mental or emotional stress (cook fighting with waitress).

The last four problems can be helped, but not eliminated entirely, by a pleasant working environment. All of the other problems are open to solution by human engineering.

Let's examine some of these problems to see what large or small amounts of human engineering could do for the kitchen environment.

TEMPERATURE AND HUMIDITY

More work is done in good weather than in bad, in summer than in winter, and in excessive cold than in excessive heat. The average person works best if his skin temperature is 91-93 F. This means a room temperature of 68-72 F. in winter and 74-78 F. in summer. Relative humidity is usually best between 30 and 60 per cent. If it goes much below 30 per cent it causes excessive drying of the body's moist surfaces. Contact lenses start to burn on the eyes, and nose membranes become irritated. In dining rooms this can reach the point where humidity must be added for comfort, but it is not so much of a problem in kitchens.

In summer, the problem is reversed. The body cools mostly by evaporation, and a high relative humidity slows down the rate of perspiration evaporation.

Dehumidifiers

One can get a cooling effect without air conditioning, with a dehumidifier. It lowers the air's humidity and boosts the rate of perspiration evaporation. At times, it can make a room feel 10 degrees cooler than the thermometer indicates.

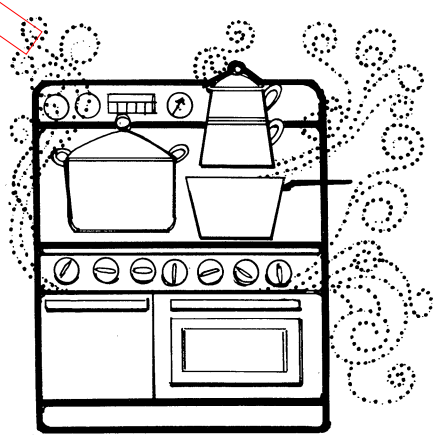
Fans

The usual method of cooling kitchen workers is to blow air about the worker with fans, thus speeding evaporation. Sometimes this is aided by fans mounted in the wall to remove high-humidity hot air from the kitchen. In the past, the makeup air for this exhaust system has been stale, moist air from the dining room. This did little for the kitchen worker.

Now better practice is to use an exhaust fan near the cooking equipment and an intake fan of slightly lower capacity on the opposite side of the room. Thus, cooking odors will not be forced into the dining room because the kitchen is under a slight negative pressure. A desirable air velocity is about 25 cubic feet per minute.

The more body the worker can expose, the more he will be cooled. Long-sleeved shirts and long pants expose only 12 per cent of the body, T-shirt and trousers expose up to 30 per cent, and brief shorts bring exposure up to 60 per cent.

It was claimed in the past that refrigerated water fountains could produce stomach cramps. Research indicates that this is not necessarily so unless workers drink water to excess. Cold water does make workers more productive and happy.



Air Conditioning

Research at Michigan State University showed that some kitchens increased worker productivity 10-25 per cent in summer with air conditioning. Other studies show that workers produce less, make more errors, and have higher accident rates when working in temperatures over 80 F. Work done on submarines showed 15 per cent more work done at 75 than at 90 F.

With either air conditioning or conventional cooling methods, much can be done to design cooler kitchens.

Reducing Surplus Heat

Insulate steam and hot water pipes, steam-jacketed kettles, pot sinks, coffee urns, and similar hot-surfaced equipment. One can cook as much food with 9 kw in an insulated fry kettle as with 12 kw in an uninsulated one. And less heat is dumped into the kitchen.

Keep steam-jacketed kettles, range-top pots, and deep fat fryers covered during cooking to reduce heat loss and BTU consumption. To avoid steam burns from the fryer, the cook should lift the back of the cover off before the front.

With the exception of bake ovens, turn oven controls on when the product is put into the oven. Preheat griddles and broilers the minimum time.

Adjust gas flames so they don't come up around the outside of the pot. Use a pot 1 inch greater in diameter than the flame.

Locate refrigerator condensing coils and hot water heaters away from the kitchen or, at least, away from the cooking area.

Locate vapor removal ventilators over loading and discharge ends of dishwashers.

LIGHTING

The use of sight and mind may consume 25 per cent of the body's energy. If eyes feel strained, the body feels tired and responds only to the most urgent commands. Causes of eyestrain are:

- Glare (rays penetrate directly from source to eye)
- Distracting brightness or motion on edges of vision
- Prolonged convergence on near object or work
- Constant adjustments to light and dark
- Constant adjustments to near and far
- Lack of convenient areas for relaxing the vision
- Inadequate lighting causing improper viewing
- Poor contrast between work and background (too little, too much)

Eyestrain shows by:

- Severe dilation (enlarging) of the eye pupil
- High blinking rate
- Increased muscular tension, nervousness, and fatigue
- Nausea or psychological irritability (extreme cases)

Light is intricately bound up with color contrasts and reflectances of kitchen ceilings, walls, floors, equipment, the worker, and work materials. To provide a satisfactory light level on a work surface in a room, a highly reflective background requires less light coming from light fixtures than a dark, light-absorbing background. Yet this reflective background should not produce glare.

Insufficient lighting, fixtures designed or placed wrong, undesirable colors in lamps, and poor background contrasts are frequent villains in employee unhappiness. For example, in one institution none of the young girls would work with an old lady in the vegetable preparation room; they said she "looked like an old witch." Seated at her bench, she was directly under a blue-white fluorescent fixture that gave her skin an unearthly pallor and emphasized the wrinkles in her face. Moving the fixture out in front of her and equipping it with one pink and two soft white lamps erased her wrinkles and gave her the pink look of the benevolent grandmother she really was. Now she also can see her work without intervening shadows.

Illumination Requirements

In a particular work space lighting should be based on the activities there and the intended psychological and visual experiences. Different activities, design objectives, and states of mind at various times of the day may require different, or even a different system of, illumination. For instance, a shopping center may cater to hurrying shoppers with a brightly lighted, overhead-fixtured cafeteria during the day and substitute the soft lamp-lighted table service of a restaurant at night. Fast food restaurants use a high level of lighting to promote fast seat turnover, and table-service restaurants use low levels to keep customers in their seats while they buy drinks.

The three general types of lighting can, in turn, be grouped into various fixtures in desired combinations.

1. **Direct** — Light rays beam directly from source to work without intervening reflectors. This tends to glare, to produce shadows and poor contrasts. Direct lighting is the most efficient use of energy.
2. **Indirect** — Light from the lamp bounces off a reflective shield, wall, or ceiling. It usually provides glareless, even light, causes less eye fatigue and discomfort than direct light, but does use more electricity. A dirty reflector can seriously impair efficiency.
3. **Diffuse** — Light is spread out by a translucent shield that prevents glare. Some minor shadowing is present, and it does use more energy than direct but less than indirect lighting. Use it to light up part, or all, of a ceiling or wall. Dust on the shield lowers efficiency.

Combinations. Frequently, offices and schools use fluorescent lamps and a grate to force direct lighting downward. Translucent shields on the fixture sides spread out and render harmless the horizontal rays, and a ceiling or a reflective shield provides indirect lighting to the far corners of a room.

Yellow-white incandescent lamps present both food and the human skin in the best light — good for use in dining rooms. Of fluorescents tested, soft white is best, followed in preference by white, warm white, cool white, gold daylight, pink, blue, green, and red. Two soft whites plus

one pale pink lamp give better food and worker lighting than one type of fluorescent alone.

Lights should not flicker. This interferes with work efficiency and is upsetting to some people, especially epileptics.

Light Levels

The amount of light from a candle held 1 foot from the eyes is a foot candle (FC), a unit used to indicate lighting levels. The following levels are recommended; but also check for the lawful levels in your state or town.

Cafeteria counters should be well lighted. A person will select less food from a low-lighted counter than from a brightly lighted one. But remember that this applies to lighting of the food; on the customer's side a dimmer light encourages him to fill his tray.

Work Surface Contrast

The work surface should be receiving the highest amount of light and the background the least. Work material should contrast with the background, but not too sharply as it tires the eyes

	FC
Corridors	10- 20
Storerooms where labels must be identified	20- 30
Storerooms where labels do not have to be read	10
Rough work areas (no reading except large print)	30
Areas where recipes and directions written in pencil must be read or doneness determined — work tables, storage cabinets, fryer and griddle surfaces, oven, kettle and pot interiors and range tops	50
Clean end of dishwasher or dishwashing sink	70- 75
Office and accounting	100-150

Avoid bright light sources or reflectance within 60 degrees of the center of vision; this avoids glare. If it can't be avoided, use a multi-bulb fixture instead of a single bulb.

After the needed or recommended light level is reached, large light increases benefit productivity but little.

High light levels are of more benefit to people with poor vision than to those with normal vision.

Older people may have half the visual acuity of the 20-year-old. Their work areas may need 5-10 more FC of light.

to make the adjustment constantly from very light to very dark shades. Three shades of difference is probably best, and surroundings slightly darker than the field of work are preferable to those that are lighter. This does mean, however, that kitchens should use a minimum of white or black. Stainless steel should be a satin No. 4 rather than the shiny No. 7 finish so often seen in serving lines.

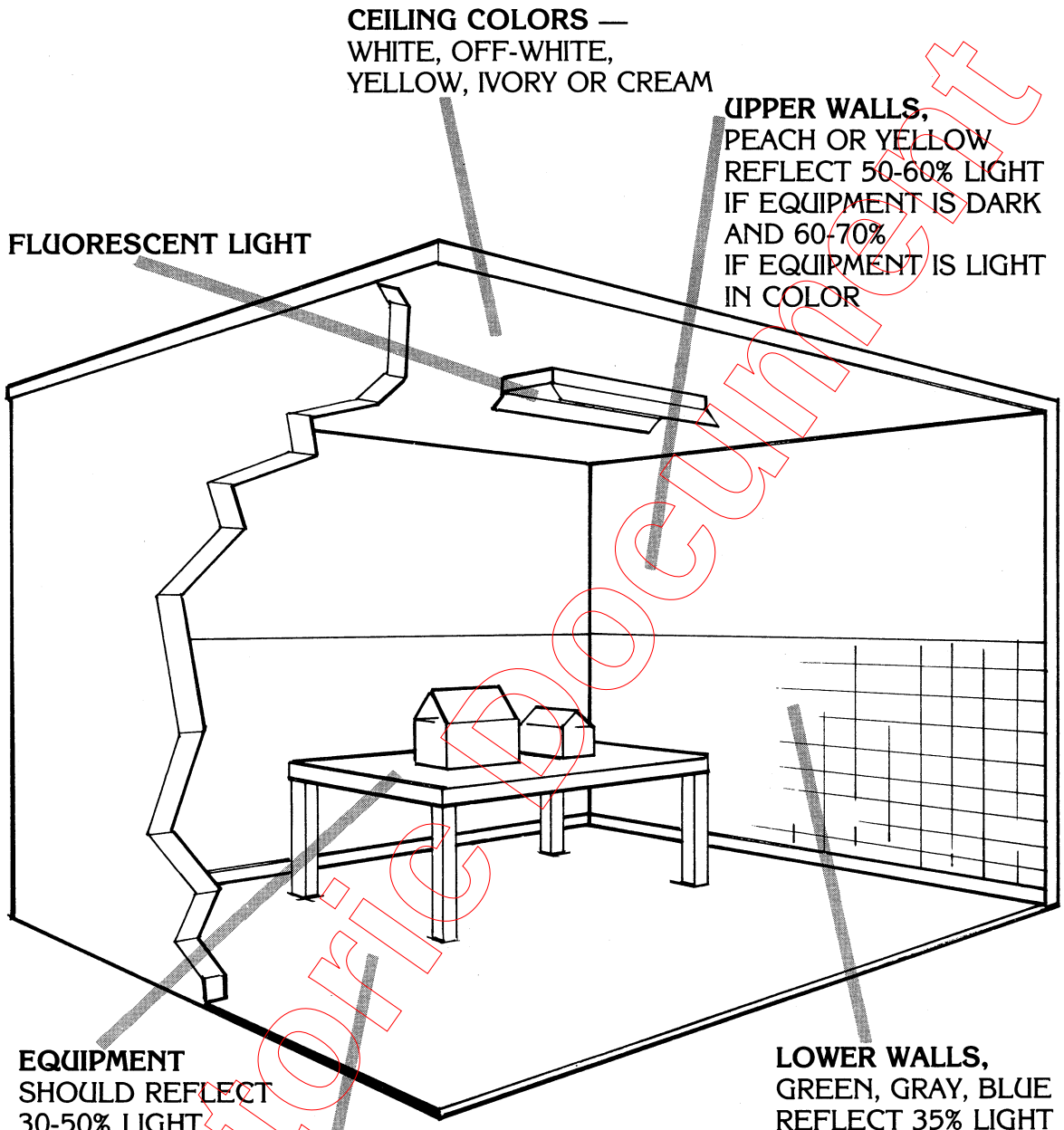
COLOR

White kitchens were foisted on food service as an indication of good sanitation. Dirt may be easier to see on white, but white is very tiring and depressing. Black is, too. Kitchens are much more pleasant and productive in peach and soft yellows. Both food and the workers' complexions look better with these colors, and both colors are good in the serving line, to encourage loaded trays. Some people choose peach and yellow tile for the lower walls and enamels of the same colors for the upper walls. Kitchen colors and reflectances are indicated in the sketch.

Proper color conditioning can do much to improve worker productivity. In 1955 one large New York organization found that it added $150 to the value of each worker per year. They found that it did the following:

- Improved production
- Provided better workmanship
- Reduced rejects and seconds
- Relieved eyestrain and fatigue
- Reduced accidents
- Shortened worker training
- Improved worker morale, absenteeism and turnover
- Improved housekeeping
- Provided better public and industrial relations

All of us recognize the value and the psychology of color in foods and in the dining areas. Human engineering for the kitchen can put to work the results of many industrial studies, and use insights from dining areas, too.



COLORATION AND LIGHT REFLECTION IN KITCHEN

Under red light, packages seem to be larger and heavier; under green, they appear to be smaller and lighter. Workers in a machine shop, who had complained constantly about the weight of black tote boxes, stopped complaining when the color of the boxes was changed to green.

Light-colored clothes are important to kitchen workers, especially in summer, to reduce the amount of heat absorbed. Tests have shown that white-topped policemen's helmets were 22 per cent cooler than black ones, and white-topped buses were 10-15 per cent cooler than those painted a dark color.

The U.S. Navy found that in Panama, lights and clothing with blue or gray in them attracted mosquitoes, but that when blue dungarees were shifted to white, the problem was lessened. On the other hand, flies dislike blues, so many operators paint their kitchen doors blue on the outside. Studies indicate that while orange may be good for encouraging chickens to lay eggs, it is irritating to high-strung people!

On a larger scale, kitchens could use the spatial as well as psychological advantage of color. Soft variations of green, gray, or blue are good in critical seeing areas. Bright luminous hues of ivory, cream, peach, or yellow are good in vaulted spaces. Light cool blues and blue-greens help cool a sun-struck room, also giving it an appearance of spaciousness.

Colors should reflect nearly 50 per cent of the light that strikes them. Long narrow rooms appear shorter if deep warm tones are used on distant walls and light cool tones on the side walls. Vaulted spaces appear lowered if lighting is reduced and the vaulted area is painted in some dark hue. Pillars need color so that people will not walk into them.

Color coding of danger areas reduced accidents 42 percent, saving $500,000 a year in the New York Transit Authority. In the U.S. Navy, it saved more than $1 million per year. Some of the coding generally accepted is:

- **Yellow** or **yellow/black checkerboard** indicate strike against, stumbling or falling obstacles, pit edges
- **Orange** marks dangerous moving parts of equipment
- **Red** traditionally marks fire equipment
- **Blue** tags or tape on a switch control indicate it is being repaired and should not be touched.

NOISE

Designers of fine dining rooms go to great lengths to subdue the noise level to an expectant hush. They use deep carpets, many-fold draperies, pads under tablecloths, acoustic finishes, sound-trapping gimmicks. Sometimes they add soft music to a level where small noises will not startle customers.

Noise is measured in decibels. A desired range is 40-60 decibels. At 80-90 decibels some deterioration of hearing occurs, and at 100 or above sound is actually painful to the ears. Sharp impact noises are the most annoying, and hums least annoying.

Outside of the difficulty in communication, workers can learn to live with noise, as do jack-hammer operators or riveters. But a worker's body never adjusts to sound. It tenses up and tires rapidly under high noise levels. Hearing acuity is quickly lost. The more difficult a task is, the more high noise will interfere with it.

Noise not only affects performance in heavy industry; some offices have similar problems. One reduced its office noise level to an acceptable range and reduced typing errors 29 per cent, machine mistakes 52 per cent, absenteeism 38 per cent, and turnover 47 per cent.

Kitchens are usually forgotten for sound reduction, but the level there quickly rises to where it shouts at the workers and causes tension and tiredness. Highly chromed and polished steel and aluminum, glazed tile, enameled walls and equipment pick up and reverberate the slightest sound. Noise bounces about in waves that intensify to a crescendo if not trapped in some manner. Dishes and flatware clatter, cans bang, pans rattle, fans roar, and workers shout to be heard over the din. But noise in kitchens can and should be controlled.

Stop Noise at Its Source

Ask workers to talk and not shout. Set down pots, pans, and dishes instead of dropping them or dumping them out of tote boxes. Remember that plastic dishes clatter less than ceramic ones.

Place asphalt coatings, which reduce bangs to thuds, on the underside of dish tables and easy-to-clean rubber mats on table tops.

Large slow-moving fans should replace small high-velocity ones. Wherever possible, place refrigerator compressors remotely from the kitchen, and use fiber glass batts over noisy machinery.

Fabric and Acoustic Materials

Some restaurants are getting fine results from using rubber-backed nylon or similar carpet in kitchens on all except the greasiest and wettest locations. It reduces the clack of heels and things dropped, it is easier on back muscles, and it absorbs many noise waves. One large restaurant saved the cost of carpet in one year through reduced china breakage. They vacuumed the carpet twice daily and shampooed it once weekly, cleaning spots as they occurred. One should consult local Department of Health rulings when considering such an installation.

An overhead 2-4-foot square honeycomb made of 18-24-inch-wide coarse fabric can trap large quantities of noise. Acoustic ceiling and wall tiles help. So do washable wall draperies. One university uses rubber-backed carpet on the walls of a noisy dishroom.

Noise Reduction Coefficients (NRC)

Using 1.00 as total reduction of 500-cycle/second sound, the following materials have NRC as indicated.

MATERIAL	THICKNESS	NRC
Carpeting (40 oz. hair felt underlay)		.60
Fabrics (18 oz.)		.55
Sound conditioning tile	5/8 inch	.70
Asbestos board, perforated	2-3/16 inch	.85
Acoustical cane fiber	5/8 inch	.69
Acoustical tile, perforated	5/8 inch	.67
Acoustical veneer, perforated	5/8 inch	.67
Acoustical panels	1 inch	.89
Asbestos board, perforated	1-7/16 inch	.97
Fiber glass tile	5/8 inch	.53
Plaster, smooth on masonry		.02
Plaster, smooth on lath		.03
Wood panels		.06

The last three make up walls and/or ceilings of most of our kitchens.

Music

Although music adds to the noise level of a kitchen, it does help reduce some of the effects of noise. RCA found that music improved productivity in factory operations 7 per cent during day shifts and 17 per cent during night shifts. It was most effective if played at the start and end of each shift, for a half-hour in mid-morning and again in mid-afternoon, with a similar pattern for night work. The best types to work by were hit tunes, snappy waltzes, and semi-classical. Religious, jitterbug, or hand-clapping music reduced productivity.

ODORS

Odor is not a serious problem in most operations because bad odor is associated with poor sanitation which is constantly combated. If odors do occur, high humidity intensifies the reaction.

Remove the offending material and scrub the area with oxidizing compounds. Remove odor from the air with activated charcoal absorbents, or add chemicals to the air to neutralize or overpower the odor. Such methods must be used with caution, however, because some foods such as butter pick up strong odors.

WORK SPACE DESIGN

A worker should have workspace laid out so that his posture is comfortable, he can see what he is doing, and he can operate his controls most effectively. Workspace design gains importance when it is recognized that more errors are caused by the situation rather than the human being.

Standing

Man at work is like a Maypole held erect by four boys pulling at ropes on four corners. As long as the pole is straight up, no one boy has to work; but if the pole bends to one side, the boy on the opposite side has to work hard, and he complains. A man bending over a too-low table has to use his back muscles excessively. These muscles complain by aching. Tensing of muscles reduces the flow of blood that brings nutrients to muscles and removes lactic acid, a waste product. Thus the pain begins. In workspace design, one strives to keep the Maypole erect by bringing work up to a height where a person can work without continued bending. It is well to use all muscles to some degree.

The arm works fastest and most accurately with the upper arm close to the body and the forearm at right angles to the body and extended forward. The work is best placed 1-3 inches below the horizontal at that point. If the forearm rises much above the horizontal, the body must lean back, and if it is lowered, the body bends forward. Either, if prolonged, causes tension and tiredness.

Work tables should be adjustable to the height of the persons using them most often. The table and the diagram deal with specific heights.

Sitting

Seated workers are usually more productive than standing ones; a worker will sit if he can. One test showed a seated worker producing 36.2 units per hour and a standing one only 32.6 units. Hand-operated controls should be in line with the hand that operates them, and foot controls should be used only by seated workers. Where workers are seated on solid benches, a 4 X 4-inch kick room should be provided. Specific recommendations can be seen in the table.

Work Table Arrangement

Although a tall worker can strain and reach out 5 feet from the table, many designers like to confine a man's work within a 16-18-inch arc from each elbow as it hangs by his side. Work materials could extend 4-6 inches farther. Others prefer to place most of the man's work in an arc of 70 degrees and within 24-26 inches from the center of the worker's belt, as the fixed eyes see only in an arc of 30 degrees and, when moving, see reliably in an arc of 70 degrees. The farther the work is from a person, the less is his accuracy in working on it.

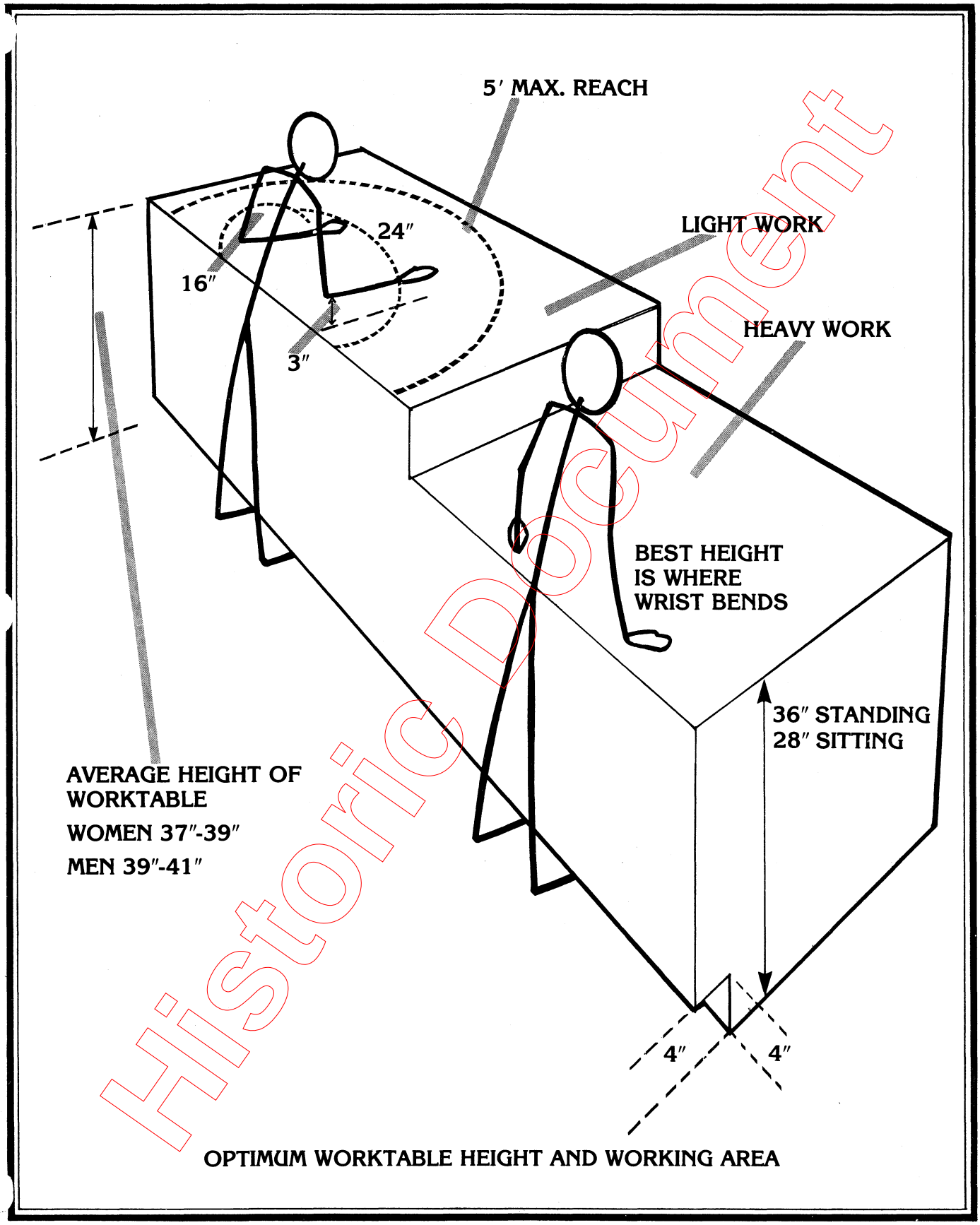
In table space for handwork, most designers provide a minimum of 5 feet of linear table front per worker. With material directly in front of him, a worker can get by with a table frontage of 3 feet. If seated, he needs no more than 32-36 inches of table front, but all of his work must be within 20 inches of him. Design and layout of the work table are particularly important; the average worker spends 60 per cent of his time there.

Storage of Hand Tools

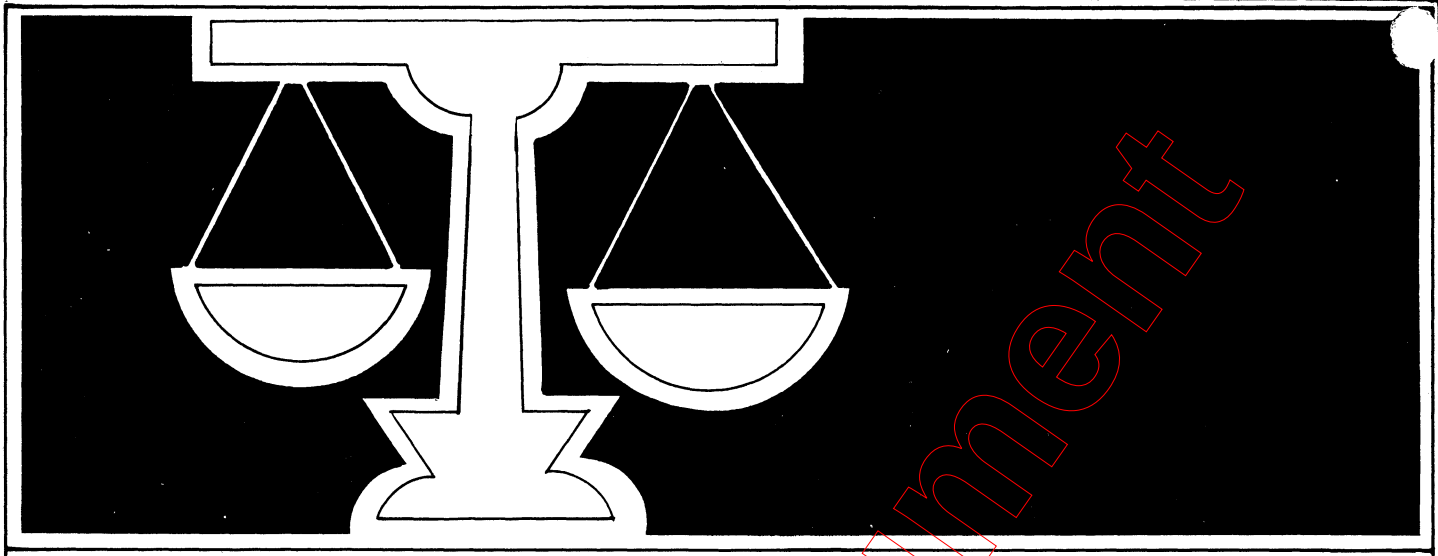
Most designers think of this space as one or more drawers under the front of the worker's table space. This is a poor location as it takes two motions to open and close the drawer. If drawers must be used, each tool should fit into a specific cut-out in a rack placed across the front of the drawer, with nothing placed in the rear. The drawer should be inclined on rollers so it will self-close, and should be easily removable for washing.

Because a worker must move to get out of the drawer's path, and because a drawer increases searching time and possibility of injury from sharp utensils, a better location for hand tools is two- or three-tier shelving directly in front of the worker and close enough to be reached without bending. Tools should be laid out here: those used by the left hand on the left side of the work area; those by the right, placed on the right. Tools most often used should be closest.

Space ordinarily occupied by drawers could be better used for a shelf 8 inches from the table top to store flat pans, cookie sheets, similar items. Below this could be another shelf for pots, bake pans, and other pans. Table top shelving might require portable covering to satisfy some local sanitary codes.



OPTIMUM WORKTABLE HEIGHT AND WORKING AREA



CONSTRUCTION DETAILS

Worktables, Chairs, Sinks

EQUIPMENT	USE	TYPE	HEIGHT	OTHER DIMENSIONS	SPECIAL FEATURES
Work table	Light work, standing	For women For men	37-39 in. 39-41 in.		
Work table	Heavy work (kneading, chopping) standing		35-36 in.		
Equipment table	Mixers, choppers, blenders, scales		36 in. or lower		
Work table	Light work, seated		26-28 in.		With solid benches, provide 4 X 4 in. kick room.
Chair — work table	Light work, standing or seated	Swivel, adjustable	24-31 in.	Room needed where feet can be tucked. Legs rest best at about 45° angle from full bend.	**Add** flat foot rest to brace feet. **Eliminate** rails as on bar stool. They press instep, cut off blood supply. **Eliminate** foot controls. Used only by seated worker.

CONSTRUCTION DETAILS (continued)

EQUIPMENT	USE	TYPE	HEIGHT	OTHER DIMENSIONS	SPECIAL FEATURES
Chair — work table	Seated work only. Feet should rest firmly on floor. Hand can be placed between chair front and thighs if adjusted properly. Body weight rests on buttocks, not on thighs.	Typist's, adjustable For women For men Padded backrest 13 in. wide 4-8 in. high. Hinged to move vertically, to press back just below shoulder blades.	16 in. 14-17 1/2 in. 15-18 1/2 in.	**Seat** 17 in. wide 16-18 in. long 17-20 in. long **Arms** separated by 19 in., project from back 8 1/2-9 in. above seat height; 10-12 in. long, so elbows rest comfortably.	**Seat** not form-shaped, but flat, fairly hard. **Padding** non-slip, non-ridged. **Forward edge** rounded. Slopes back to rear about 6° from horizontal.
Chair - desk work	Office. Worker's legs can be placed under desk top.	Desk chair, adjustable to desk.	Worker's arms at same height as desk top.		
Chair	Relaxing. Legs rest best if bent 70° from extended position.	Lounge or padded.	14-16 in.	Up to 20 in. deep. Up to 20 in. back height. Arms separated by 22 in.	Deeper, springier padding than work chair.
Chair	Dining. Coordinate with table.	According to decor.		Back not high enough to catch waiter's elbow.	
Sink	Dishwashing	For women For men	Top edge 2 in. wide. 37-38 in. high 39-40 in. high	Bottom should be at height of thumb tip. 27 in. women, 29 in. men	
Sink	Potwashing	For women For men	Top edge 2 in. high. 37-38 in. high 39-40 in. high	Bottom soak sink 6 in. deeper than dish sink.	No hand utensils in this pot sink.

Other Storage

Other kitchen storage should be placed so that items most frequently used are close to the work surface and between waist and chest height. Shelving above eye height or below waist height is useful only to the extent that it can be seen by the standing worker. For storage below waist height, some designers use pull-out sliding shelves or drawers or swing-out shelving attached to swinging doors. That above eye height is more useful if canted forward so that items can be identified easily, and if barred to keep foods from falling off. Most commonly assembled foods are grouped together.

Steam-jacketed kettles should be designed with rims no more than 36-38 inches from the floor and depths no more than desired capacity. Three-deck roast ovens are undesirable because of the possibilities of burns and the difficulty of seeing into the top and bottom decks. A two-deck oven is preferable, with the bottom deck at least 20-24 inches from the floor.

AISLES AND PASSAGEWAYS

Most aisles and passageways in kitchens are too wide and hazardous for human use. Aisles should be free from obstructions and corner overhangs that workers can run into. They should be of a minimum width, allowing for the functions to be performed in, or on, either side.

If a worker is performing at a table on one side of an aisle only, he needs but 30 inches of aisle width. Another 6 inches will permit a man to work at a bench on the other side of the aisle, while a 42-inch aisle permits a worker to pass behind them. Two men walking past each other in a corridor require 52 inches, while a cart needs its width plus 10 inches on each side. To bend over, a man requires 36-38 inches and if he gets down on his hands and knees, he needs 45 inches of aisle space.

These are minimums, but the maximum allowed should be no more than another 6 inches in each case. Wide aisles waste a worker's time to the tune of approximately 10 percent of his gross pay annually. Extra unnecessary aisle space can cost $50-$75 per square foot. Thus excess aisle width is money down the drain.

Aisle Design

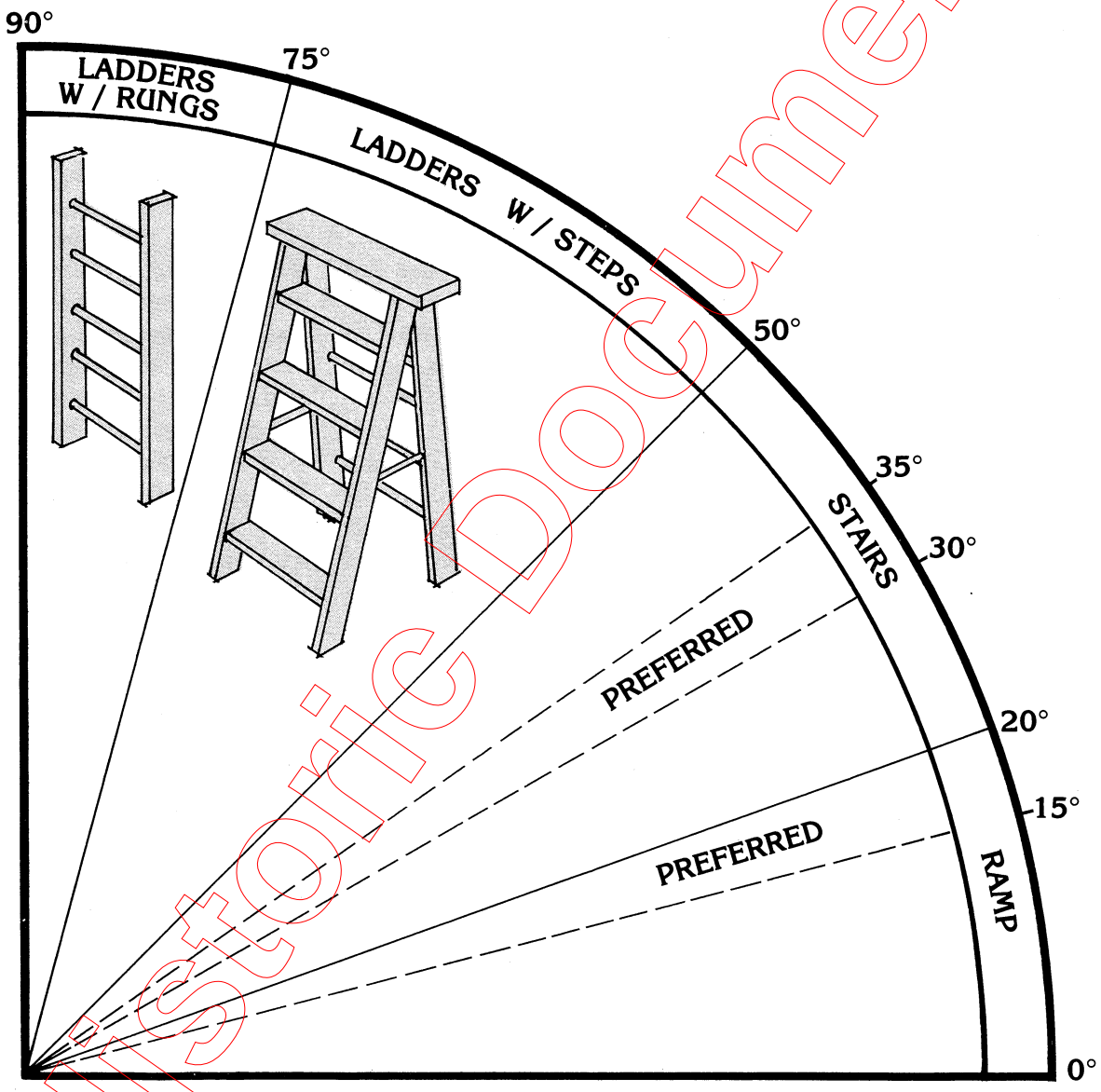
- Provide aisles with as few corners and bends as possible. Each bend or corner is a potential disaster area.
- Locate aisles so they are paths of minimum travel. Most designers seek to have food travel as short a trip as possible because it is deteriorating as it moves.
- Mark travel guides on walls and floors. Don't leave anything to chance.
- Make intersections at 90 degrees for minimum space usage.
- Keep aisles clear of clutter. Any obstacle is an accident waiting to happen.
- Avoid aisles against blank walls; they are wasteful of space.
- Avoid one-way traffic aisles. People won't use them this way.
- Locate equipment no closer than 6 feet from swinging doors.

RAMPS, STAIRS, LADDERS

Any type of stair or ladder should be used to a minimum as they are chronic sources of accidents. Storage of all foods, pots, utensils, and other supplies should be within sight and reach of the worker standing on the floor, if possible. All necessary stairs, ramps, and stepladders should be carefully designed, clearly marked and free of accident-causing features. The diagram shows incline allowances for all of these.

Ramps, and usually stairs, should have a wide yellow strip at bottom and top. If possible, on the approach to the ramp, there should be printed in the same color **Ramp Up** or **Ramp Down.** If the ramp is placed over stairs, and stairs are still visible on one or both sides, it is best to have handrails about 35 inches above the ramp. Without this, there should be a yellow line down each outer edge of the ramp.

Stairs, steps, or rungs should be, in each case, the same distance apart. Often the worker cannot see where he is placing his foot, and if one stair is a half inch higher than others in the set, a serious fall can result. Stairs should be 9 1/2-10 1/2 inches deep and have a 5-8-inch step-up or riser. The nosing out over the riser may project 1-1



ANGLES OF INCLINE FOR RAMPS, STAIRS AND LADDERS

1/2 inches. No riser should be over 8 inches high, and depth of the step should be at least equal to the riser. A handrail with a diameter or flat surface that can be grasped (not more than 2 1/2 inches wide) should be placed so that the top of it is 34 inches above the front edge of the steps and 36 inches above the landings. A landing should be provided every 10-12 treads.

In the interest of safety, it is well to paint the front edges of the steps bright yellow, particularly the top step and the bottom step. If the steps or the workers' feet may be wet or slippery, it is well to sprinkle some fine sand or silica into the wet paint on the top front surface of each step or attach self-sticking abrasive strips at these points.

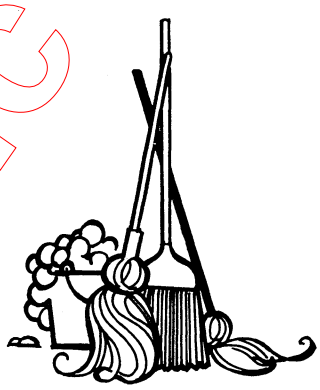
Flooring

Flooring should be compatible with the heaviest traffic that will use it. At the same time, if it is used for much human walking, it should be as resilient as possible, consistent with the heavy cart traffic that uses it. This means that heavy-traffic materials would be suitable for truck aisles, and the colorful, resilient rubbers and vinyls for heavily populated areas. Wood and the resilient tiles are much easier on leg and foot muscles than concrete and quarry tile.

Skid Prevention

Keeping resilient tile and other hard floorings non-slip or non-skid is particularly difficult if moisture or grease falls on them. Few waxes in themselves can be blamed for sliding falls. Falls are usually caused by some liquid material on the surface or by the poor condition of the worker's heels or soles. To combat this slip hazard, some manufacturers supply a mixture of hard and soft waxes; or add a colloidal silica, a non-slip abrasive, to the wax; or use abrasive strips that are glued to surfaces in the most dangerous areas. Quarry tile with varying degrees of abrasiveness is available, although some managers deplore wearing out floor mops on it. A little greater expense in mops is probably paid off many times in reduced claims from workers who have fallen.

In front of fryers, griddles and ranges, sinks, dishwashers, mixers, and other equipment, if there is spatter or dripping of water or fat, some type of removable non-skid, machine-washable floor covering is desirable. This must be non-skid in all directions, and its corners or edges should not curl up to create tripping obstacles.



CONTROLS AND DISPLAY

In purchasing any equipment one should keep in mind human capabilities, frailties and needs. The average man seeks to routinize and sequence his tasks so that he can think of something else while he is performing them. If he has to think about everything he does, he usually works slower, using greater tiring effort. While routinized work is desirable, the next problem is to get the worker to break his chain of faraway thought, read important dials, and accurately adjust controls. Where tasks can be done automatically by controls, these should be used.

Similar problems face drivers of vehicles, pilots of planes and crews of ships. Much research has been done in design and location of displays and controls that will (1) attract the operators and (2) move them to make the correct response. A sharp, fairly high-pitched sound gets the fastest response, and flashing red, yellow, orange or white lights are next.

Best Designs for Display

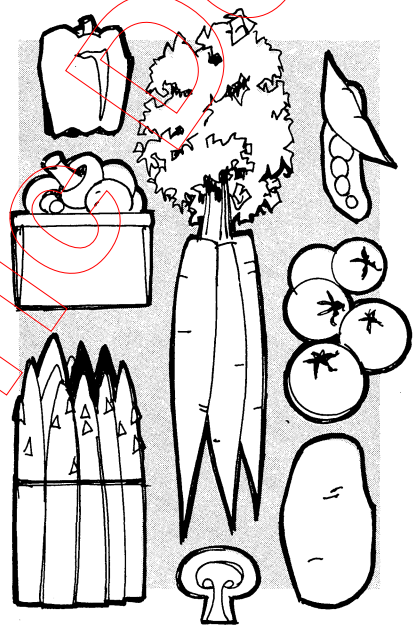
- Movement of display indicator is in same direction as movement of controls.
- Shape of temperature indicator is a straight-line bar. Less desirable is a fan shape, and least desirable are complete circles (difficult to see numbers and relationships) or a partial dial.
- Black numbers, graduations, and pointer tip on white background.
- No more than 10 graduations between numbers. Pointer should not cover graduations.
- Numbers and letters in capitals, with letter dimensions at

a ratio of about 3:5. For normal viewing at 36 inches, letters should be a minimum of 1/3 inch high; at 6 feet, they should be 3/4 inch high.

- At a specific point, or in a range where temperature is acceptable, display should be marked in green. Above and below this area, red marks should indicate temperature quickly from a distance.
- Best placement is below eye-level and as close as possible to the line of worker's sight. This is probably above the center in back of the cooking product.
- The necessary minimum to do the job.

Best Designs for Controls

- Close to display indicators. However, controls on the back of a heating device do get greasy and too hot to handle.
- To the right side of equipment, and where food will not fall on them.
- Front controls are least desirable, particularly if at right angles to stove top, because seeing graduations and relationships is difficult. If front controls must be used, controls should be tilted back 45 degrees from the vertical, with each fairly well in line with unit it controls, and back unit controls slightly above front unit controls.
- Control of frictional types requires more force as they approach upper limit of power (adding protection against error from eyeglasses that fog up or control knob figures that have worn away). A clicking type of control is of less value but nevertheless helpful. In any case, a knob or switch for "off" is essential.
- The necessary minimum to do the job. If many indicators must be used, they should be varied and distinctive — a sound device to indicate that water is too low in a dishwasher; a flashing red light for too hot fat temperature; a green or white light to indicate "power on."
- All controls and displays between 32 inches from the floor and eye height. No worker should have to bend more than 16 inches from normal vertical reach to handle any control.



WORK CENTERS

Although most designers seek to arrange work centers in an operating flow line from Receiving to Service, few give much attention to the food flow and human engineering within individual work centers.

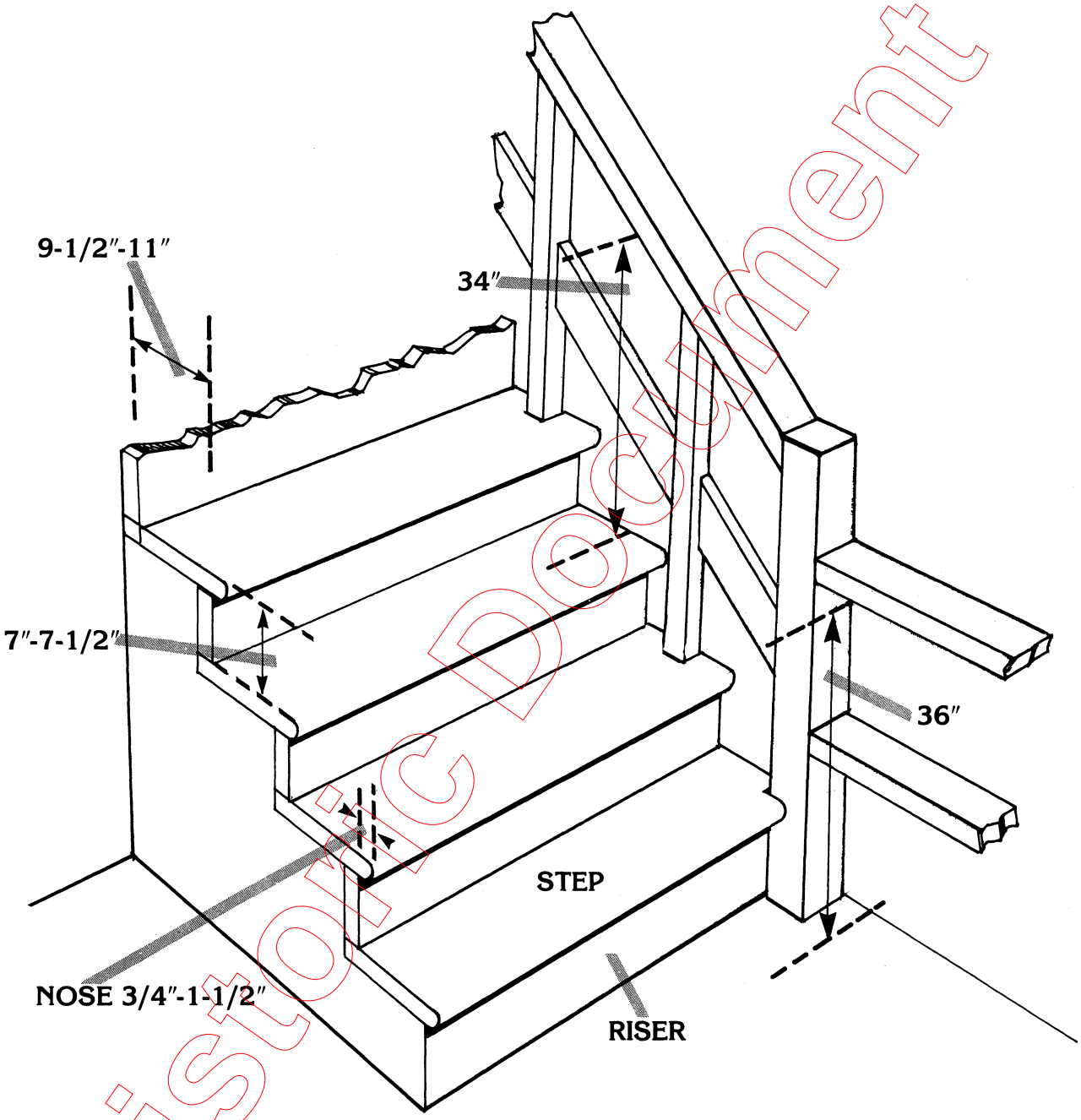
In general, food should loop around the work center from left to right and end up close to where it entered the work center but farther along on the food flow line. A Vegetable Preparation work center, for example, might set up from left to right — table, peeler, double sinks, drainboard and then across the aisle to table, vegetable cutter, table, and finally to the refrigerator to hold the product at the entrance to the Cooking work center close to the starting point of the Vegetable Preparation work center.

It is good human engineering to provide tables at heights where (1) all work can be performed close to elbow height, (2) food containers can be slid or rolled rather than lifted, and (3) materials can be laid out where workers can use a left-to-right routine — reach for and position food with the left hand, work on it with the right, and drop/dispose of it with the right hand.

Receiving

To reduce travel, receiving should be located close to the entrance of the kitchen and the various storerooms. Wherever possible, the unloading platform should be at truck body height so that pallets can be easily removed with a pallet truck and carts can be run in and out to remove loads. In some cases, this means that the platform must have an adjustable ramp to meet various heights of trucks.

Scales located on the platform should be at a height that most goods can be slid or rolled



STAIR DIMENSIONS

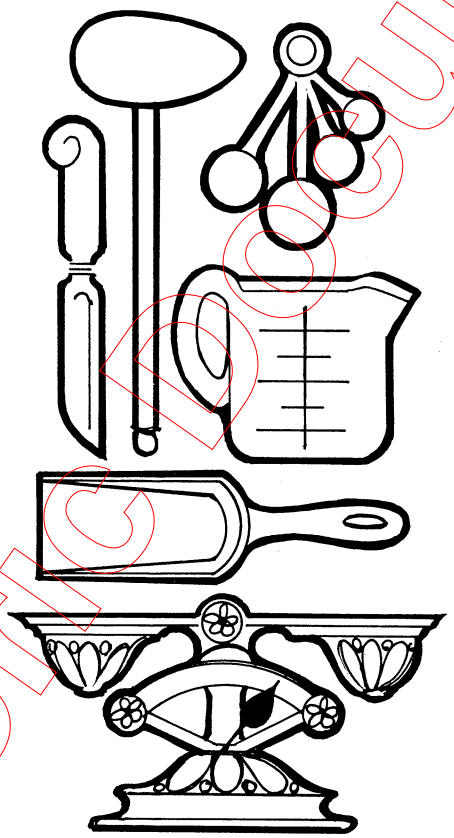
onto them from carts without lifting. Wash and trim vegetables and the like and measure into batch lots on the receiving platform.

Loads should be limited to 50 pounds if they must be lifted 4 feet from the floor and to 100 pounds if lifted 3 feet. Where things must be carried, workers should be encouraged to carry them on their backs. It takes 2-1/2 times more energy to carry something in the hands rather than on the back. The largest load for a person to carry 85-95 yards in 3-3-1/2 minutes is 35 percent of body weight. Some states prescribe a maximum load of 25 pounds for women and 50 pounds for men, but actually the average woman can carry 33-44 pounds and the average man 80 pounds. Usually a woman's strength is about two-thirds that of a man, so plan accordingly.

Cold Storage

Walk-in refrigerators should be designed with ledges so that wheeled shelving or carts loaded at Receiving can be wheeled right into them without rehandling food. Floors should be non-skid and be easy to clean. Lighting should be arranged so that contents of all shelving can be identified quickly. A door should open mechanically when activated by an electric eye, foot lever, or pressure mat and self-close after the door opening is cleared.

To avoid much opening of heavy doors, use of heavy see-through plexiglass doors should be encouraged. If people must move in and out of the refrigerator to get small quantities, consider several reach-in doors opening on to shelves. This way most frequently used materials and the day's recipe ingredients can be available without use of the heavy walk-in doors. Even better would be pass-through refrigerators between the Vegetable Preparation work center and the Cooking center and also between Meat Preparation and Cooking to avoid having to haul ready-to-cook foodstuffs in and out of the walk-in refrigerators.



Unrefrigerated Storage

While it is desirable to have unrefrigerated, or dry, storage shelving on wheels for easy cleaning, the weights of bagged and canned materials may make this difficult. Shelving should be off the floor so that one can clean beneath it.

It is desirable to set up loose package shelving so items can be loaded from one side and removed from the other. Thus old stock can always be pushed to the front and used first. If metal wire shelving is used with wires perpendicular and slanting down to a stop bar in front or at the removal point, often the containers will slide forward by force of gravity.

A storeroom clerk could provide desirable service by assembling and measuring ingredients for each recipe and delivering them ready for use to the cook's work area. This would (1) reduce high-cost cook travel and measuring, (2) provide more consistent quality by eliminating guesswork in times of hurry, and (3) better utilize low-salary personnel in time-consuming tasks.

If the storeroom clerk performs this task, the storeroom should contain scales, measures and containers, can opener, box opener, trash can, scoops, and a small sink. Lighting should be adequate where labels, lists, and recipes are read and scales are used.

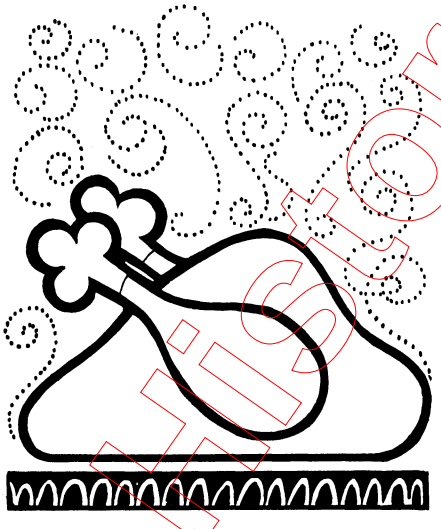
In the large kitchen where the storeroom is frequently used from both sides of the kitchen, it may pay to place the storeroom centrally or split it into two rooms on opposite sides of the kitchen. The central area location is usually more important for the food production work center and thus is most desirable unless a high degree of food control is needed. The unrefrigerated storeroom should be close to the bakery and cooking area and, to a lesser extent, receiving, service, dishwashing and pot-washing.

Meat Preparation

Some institutional and most commercial operations have done away with meat preparation facilities, because it is more economical to purchase all meats prefabricated. Those who do maintain cutting facilities should have tables at two heights, (1) at wrist height for hand cleaving of meat and holding meat molders, grinders, and tenderizers, and (2) about 3 inches below elbow height for light trimming and cutting jobs.

The slicer should be on a large wheeled table for use in kettle, oven and meat preparation areas. Knives and other hand tools should be located in washable sheaths on the side or over the back part of the tables and directly in line with major work surfaces. Most-used bake and sheet pans should be located under the tables on a shelf 8 inches below the top.

The meat preparation area should be located between meat



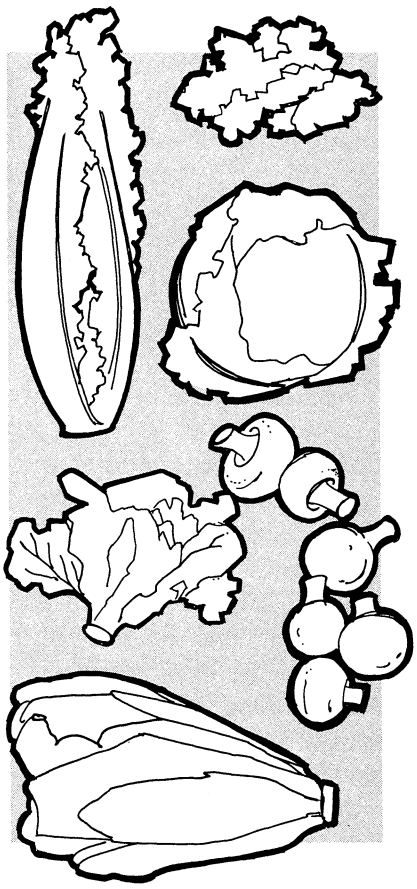
refrigerator and frypan, griddle-oven-frying-kettle cooking area to reduce travel. Lighting should be good on the meat cutting tables to avoid cutting accidents. Flooring in front of them should be abrasive quarry tile to prevent sliding. An adjacent sink is to provide water for roast pans and for cleaning the butcher areas. To hold the prepared meat a pass-through refrigerator between meat preparation and cooking is desirable.

Vegetable Preparation

This should be located between the vegetable refrigerator and the steamer, kettle, and fryer part of the cooking area. Again, tables adjusted in height as in the meat preparation area should be provided. Two shallow sinks together and two drainboards are needed. The sink bottoms should be between 27 and 29 inches from the floor, depending on whether the user will be female or male. The top front edges should be a couple of inches below the worker's elbow height.

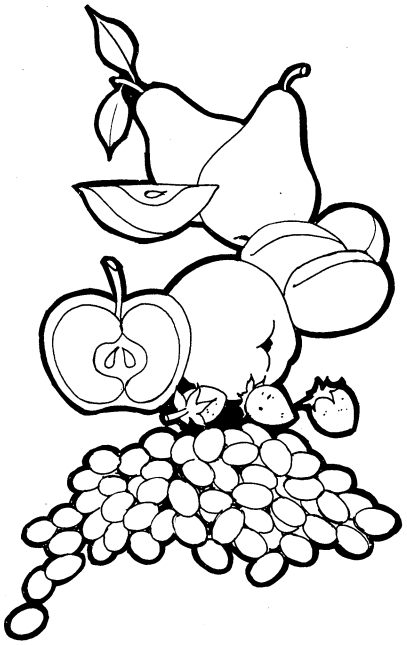
The left-hand drainboard (or the one in front of the mechanical peeler) should have a 4-inch high fence around it except on the sink side where there should be a removable barrier of the same, or greater, height. On the worker's side of the drainboard should be a hand-on peel receptacle. In this way potatoes from the mechanical peeler will first land on the drainboard where they can be trimmed, dropped into the adjacent sink or a wheeled tub of water, or even dropped through a French-fry cutter, also on wheels, and then down into a portable tub of water. Handling should be minimized.

The right-hand drainboard should be used primarily to drain washed and trimmed greens. It usually should be adjacent to the table where bulk greens and individual salads will be prepared. This table, in turn, should be directly opposite a high-humidity, reach-in refrigerator, half of which may be used for ingredients and the other half for storage of trays of salads. One should be able to place all racks in one compartment of the refrigerator on a carrier cart as a single unit for transport to the serving line refrigerated pass-



through. Or some prefer to use a refrigerated cabinet to hold prepared salads; then the whole cabinet can be wheeled into an

open space behind the serving line and plugged into a power source. Heights of tables used to mince or cut salad greens, make



up individual salads or portion out desserts should be 2 or 3 inches below that of the worker's elbow. Swing-out pot or kettle supports may be set at proper height on the right side of the work area to permit drop of prepared foods.

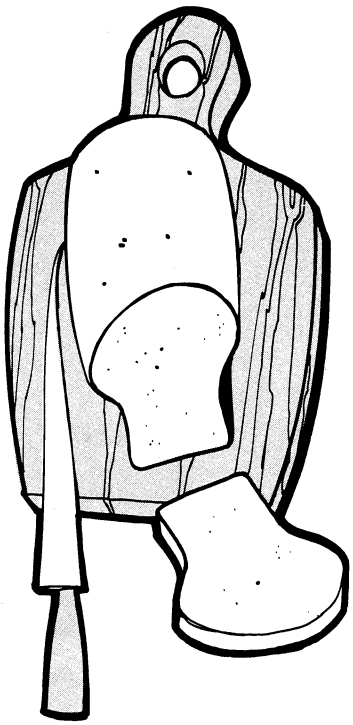
Any mechanical vegetable cutters or choppers should be on low tables or carts so they can be loaded below elbow height. The cut vegetable can then fall into a table-supported pan or a wheeled bin or tub. A generous size tray should hold the food awaiting feeding into the loading opening. Because of its great torque, the vertical cutter-mixer should be firmly attached to a sturdy table (small model) or set squarely on the floor close to a drain and a water supply from a flexible hose to ease cleaning. The vertical cutter-mixer would preferably have a timer that will shut off the unit at completion of cutting or mixing. The proper times for each operation should be posted nearby or printed on the timer face. Also, it is desirable that the nut holding the cutter in place be a wing-nut type to permit removal without tools. The device should also be equipped with a faster brake than heretofore, as it is still possible for the operator to get the lid of the device open and get his hand down into a light product like bread crumbs before the cutter stops.

Production

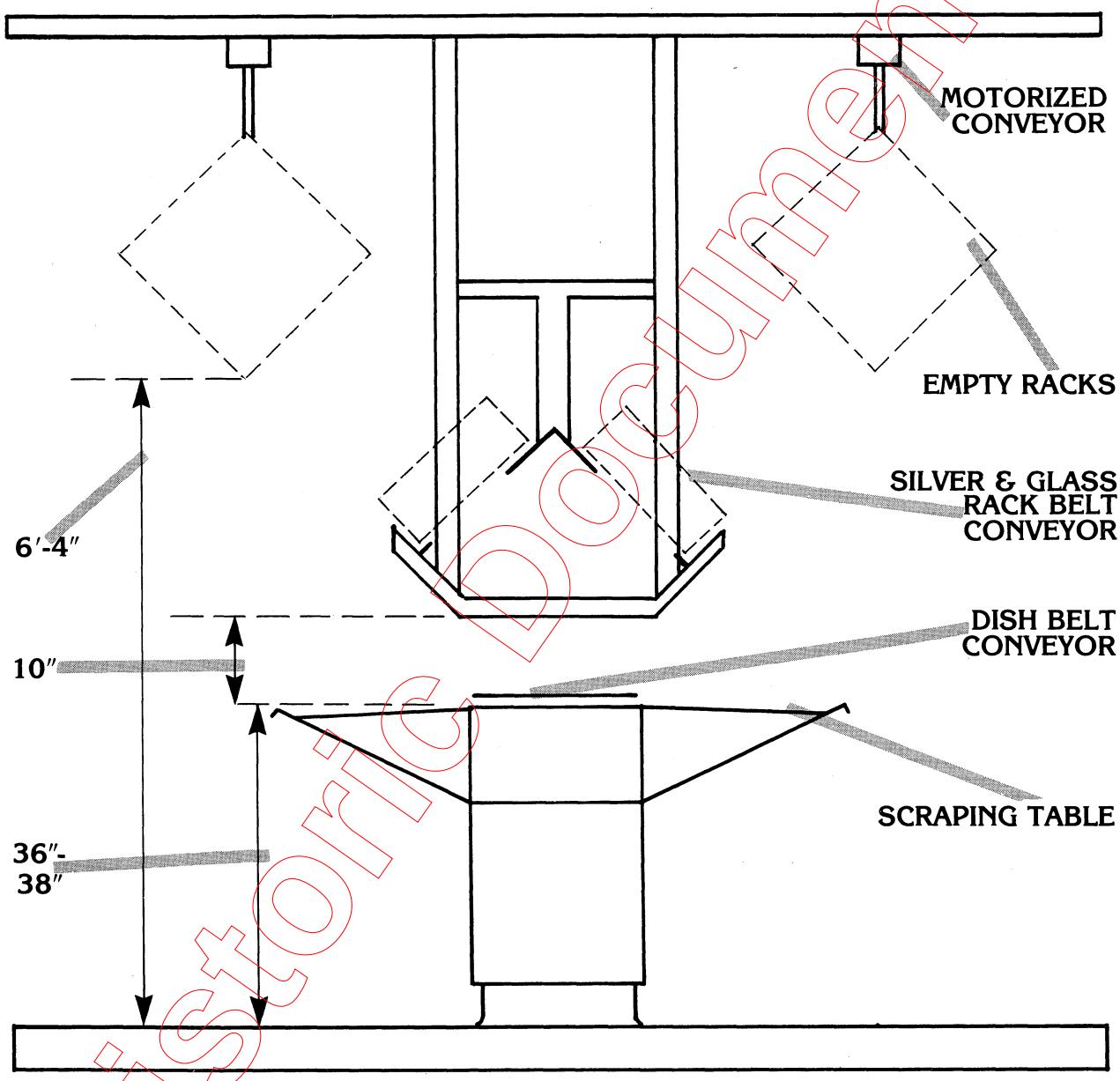
The major cooking facilities should be located so final preparation equipment (griddles, fryer, broilers, pressure cookers) are in, or close to, the serving line or serving area, and ovens, ranges, and kettles are close by. Products from this equipment lose quality quickly. As production draws heavily on unrefrigerated storage, refrigeration, vegetable preparation and meat preparation should be located between receiving and production. As production is the major soiler of kitchen utensils, pots and pans, the potwashing area, too, should be close by, but not in, the food flow path. While in some kitchens the bakery is combined with production or cooking, in others it is separate. As they commonly use the same mixer and sometimes the same ovens, the two work areas should be close to each other. Dry storage should be close to the bakery.

Work tables should be provided beside fryers, griddles, ranges, slicers, steam-jacketed kettles (may be racks hanging on sides), molding machines and in front of ovens, steamers, broilers, pressure cookers and refrigerators. Condiments and small utensils should be duplicated at each point of frequent use. Adequate numbers of other pots and pans used in production should be stored close to the point of first use. While stored under-counter, they should be brought up with under-counter shelving as close to waist height as possible.

Water and sinks or drains should be provided beside ranges, frypans, steam-jacketed kettles, and cookers in a central location in the cooking area,



available for oven use and cleanup. The cooks should have a large fixed, or wheeled sink or other area for storage of soiled pans and utensils until the potwasher picks them up.



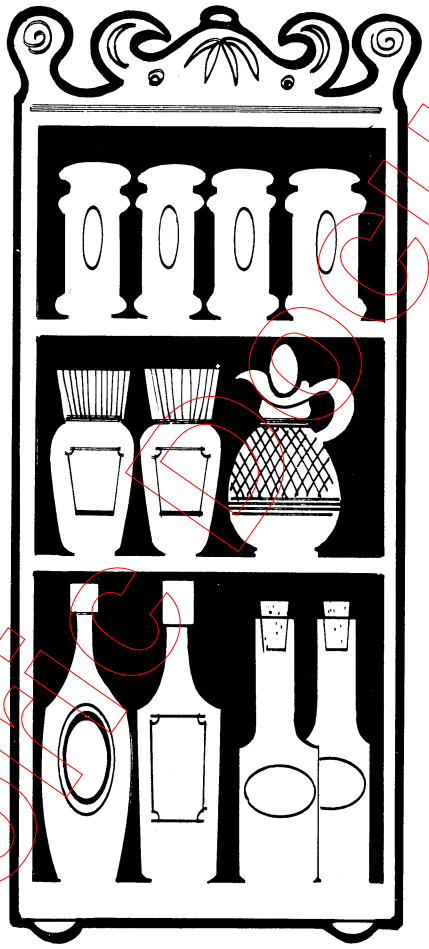
DISHROOM HEIGHTS

Some managers ask cooks and other users to pre-wash utensils to make the potwasher's job easier. Others lean toward providing soak sinks in each major work center where many pots are used. Cooks cost too much for them to wash pots or even to walk to the potwashing area. The aim should be to make each work center as self-sufficient as is feasible so that costly personnel can minimize unproductive movement, and everything they need is at their fingertips.

Equipment in production or cooking areas should be arranged near and in order of most frequent interuse while food proceeds from storage and preparation to cooking and to service. The lines of equipment where much hand and machine work must be applied to food should allow it to flow from left to right as the cook faces it. That is, he picks up the material with his left hand and holds it while the right hand operates on it and drops it to the right.

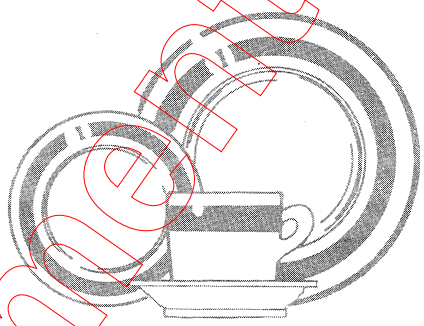
Service

Holding or support storage should be immediately in back of the area that it supports. All products that can be pre-portioned should be so served. The customer serves himself everything that he can do economically and without slowing the rate of service. Where it is desirable for the customer to serve himself but this uses too much time, set up serving counters so that customers can pass down both sides. Dispensers, such as milk and juice dispensers, can be easily reloaded from the back or should be on easily turned swivels so they can be reloaded from the service side. Less flatware will be used if it is placed at the end of the serving counter. Fewer condiments will be used by placing them at several locations in the dining room area rather than on each table.



Dishwashing

In table-service restaurants dishwashing rooms are generally placed where waiters can deposit soiled dishes on the way to pick up the next order. In self-bussing cafeterias, the best location for the dishroom is close to where customers exit. In some cases, a conveyor is needed that stretches out toward the exit to catch the dishes and transport them to a dishroom.



Where dishes must be used twice or more at a meal period, a short route with a minimum of cross-traffic is needed between dishroom and serving area to return dishes for next use.

In the dishroom, trays of dishes can come in so the tray stripper does not stretch much more than 3 feet to lift trash or dishes from the trays. The tops of the racks, as he loads and unloads them, should be about 3 inches below the worker's elbow. This should govern the table height. Cup, glass and similar racks should be placed above the table and tilted toward the worker at the lowest height possible that still allows the worker to see materials on incoming trays and the plate racks resting on the table.

Floors should be of non-slip material that is easy to keep dry and clean. To reduce noise, plastic or fiber glass composition or plastisol-coated wire racks may be used, mastic undercoating under the table tops, and rubber mats on tables where trays or racks will not have to slide. Lighting intensity at the soiled dish end of the dishwasher may be 30-50 FC, but at the clean end it

should be 75 FC or more for detecting light-colored soil films on dishes. Good ventilation can keep temperature, humidity and odors within acceptable limits. Of particular benefit are exhaust hoods at each end of the dishwasher.

To reduce lifting, carrying and walking, it should be possible to slide racked dishes (for rack type of machine) or piles of dishes (for conveyor type) to the loading end of the dishwasher. At the discharge end, one should be able to place clean dishes into a wheeled self-leveling dispenser or dishcarts with minimal bending, twisting or walking. A slide or conveyor should be available to return empty racks from the clean end to the loading end.

All dishwasher controls should be automatic-temperature controls of the wash and rinse tanks, the final rinse spray, and the regulators for the detergent and rinse aid. Temperature indicators with large, easily read displays should allow the operator to check water temperature quickly.

Hand dishwashing sinks should be no deeper than the height of the worker's thumb from the floor, so that he can grasp dishes on the bottom with minimal bending and stretching. The sink front should be 2-3 inches below the height of the worker's elbow and not over 1-2 inches wide. Dish baskets with handles that project above the surface of the water enable the dishwasher to place dishes for rinsing and sanitizing if this is to be done by hot water. Otherwise, the worker tends to use too low a temperature for sanitizing or for warming dishes for quick air-drying. Both hand dishwashing and potwashing sinks should have thermostatically controlled steam injectors or other means of maintaining them at some set temperature.

Potwashing

This area is often overlooked in kitchen design for more effective human use because the potwasher is usually a lowly paid worker. If one designs spaces so that the potwasher can do his job more efficiently and faster, he can be available to perform tasks usually required of more expensive labor.

The most usual error in designing for handwashing is to make sink bottoms too low and too deep from front to rear. The bottoms of wash and rinse sinks should be no lower than the thumb, but the soak sink may be 6-12 inches deeper if small pans and hand utensils are kept out of it. Thus the need for deep bending is eliminated.

Another frequent error is to have everyone in the kitchen carry his own soiled ware to the potwasher and frequently go to this area again to pick up his gear after cleaning. This is wasteful of skilled manpower. The various work centers should have pick-up locations, preferably soak sinks, which the potwasher will visit to pick up soiled ware while he returns clean ware. If the potwasher is too busy to do this, some other low paid individual should be delegated.

The potwasher should work in a well-ventilated space. Floors should be non-skid and well drained. Wheeled drain racks should be provided to return cleaned pots to their storage location, and there should be some type of high-mounted sink or cart to pick up soiled utensils.

While it is not often realized, both dishwasher and potwasher are happier and more productive if they have a window through which they can see outside activity. Also, they are more productive if the supervisor visits them periodically to see if they are doing their jobs properly and to impress them with the importance of their jobs to the overall operation.

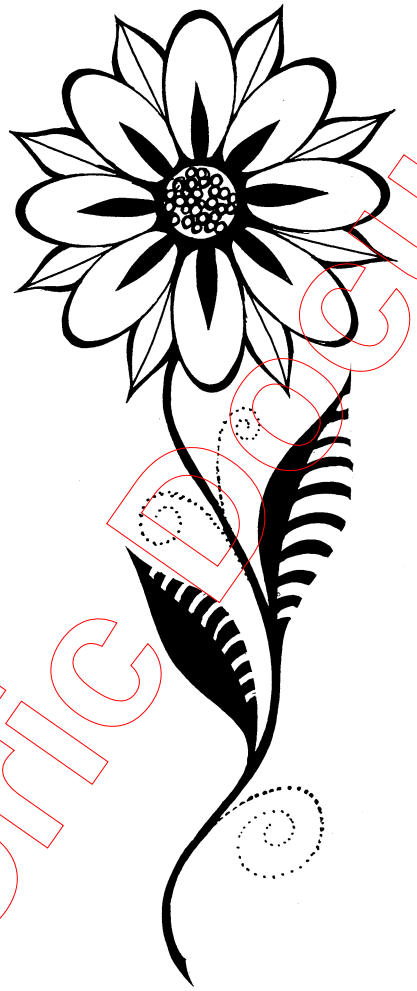
PLANNING FOR THE WORKING OLDSTER

In most industrial work today, the older worker (between 40 and 65) receives little special consideration. The feeling of management is often "if he can't keep up, let him go." In food service, however, the shortage of skilled and unskilled workers argues against this callous attitude. Attention must be given to designing the older worker's environment for better use of his outstanding attributes — experience, care and attention to detail, low rates of tardiness, accidents, and absence, decreased need for sleep, pride in work and desire to earn his own way.

First of all, not all old people of the same age have the same degree of aging in body and mind. In many cases, a person of 60 may be less senile than one of 40, especially if he was bright and active to start with and has kept his mind or body properly exercised over the years. If he has had a job that required little mental or physical effort, and has done little to build up his mind or body when not at work, then he grows old quickly and is a poor risk as a worker.

It has been found that up to age 60-65, older workers have little loss of productivity, although they may not be as quick physically or mentally. They make up for losses by using their expertise to reduce learning time and lost motion, taking fewer waits and pauses (working steadier), and by determining the easiest method. Because they won't let their hands get out of sight, they have fewer accidents.

Muscular strength decreases about 10 percent between ages 30 and 60, mainly in the back and legs, and to a lesser extent in the arms. Thus, carried loads must be lighter, but arm tasks need not be changed.



The oldster's memory of immediate things is less efficient, but long-term memory of old skills is little diminished. Rather than giving detailed oral instructions to the older worker, it is better to give them in large writing so that he can refer to them as needed.

He cannot take cold as well as when he was younger, so he should be given a 75-80 F. room in which to work. He cannot adjust to glare or sharp impact noises as well as formerly, so be more careful of his lighting and the area noise. Don't think you can push him to meet decreased time schedules; he doesn't adjust operational speed nor meet time pressures as well as he once did.

While he will not change jobs, be ill or have accidents as frequently as when younger, his recuperation will be slower. For each five years of life, about one day can be added to the recuperation period for accidents or illness. Some workers, when a job is lost, can never get, or will not try to get, a new one.

If you are using an older cook, taste the broth more frequently, particularly if you are feeding youngsters. The older worker loses some of his ability to smell and taste and may overseason if he is not checked periodically. Although his awareness of color difference remains fairly acute, he does need 10-20 FC more light on his work. When you give him written instructions, be sure they are in large print or writing.

Some of these cautions may give the impression that the older worker is not a good investment. This is simply not the case. On the average, he is far above the sub-25-year-old worker, usually on a par with the 25-35-year-old worker, and usually has to take his hat off only to the 35-45-year-old in productivity.

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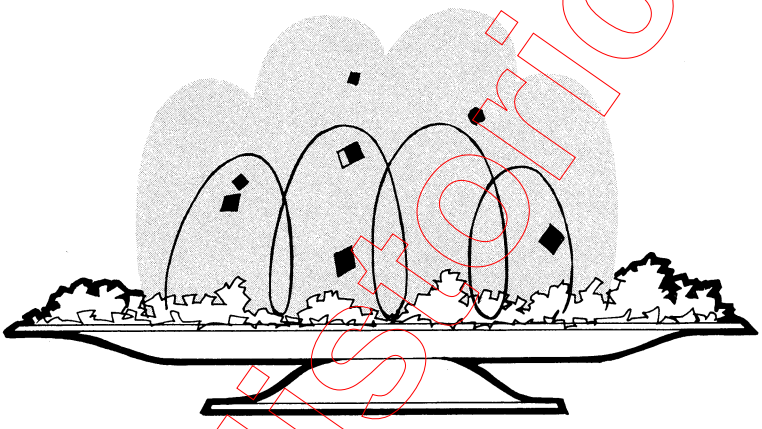

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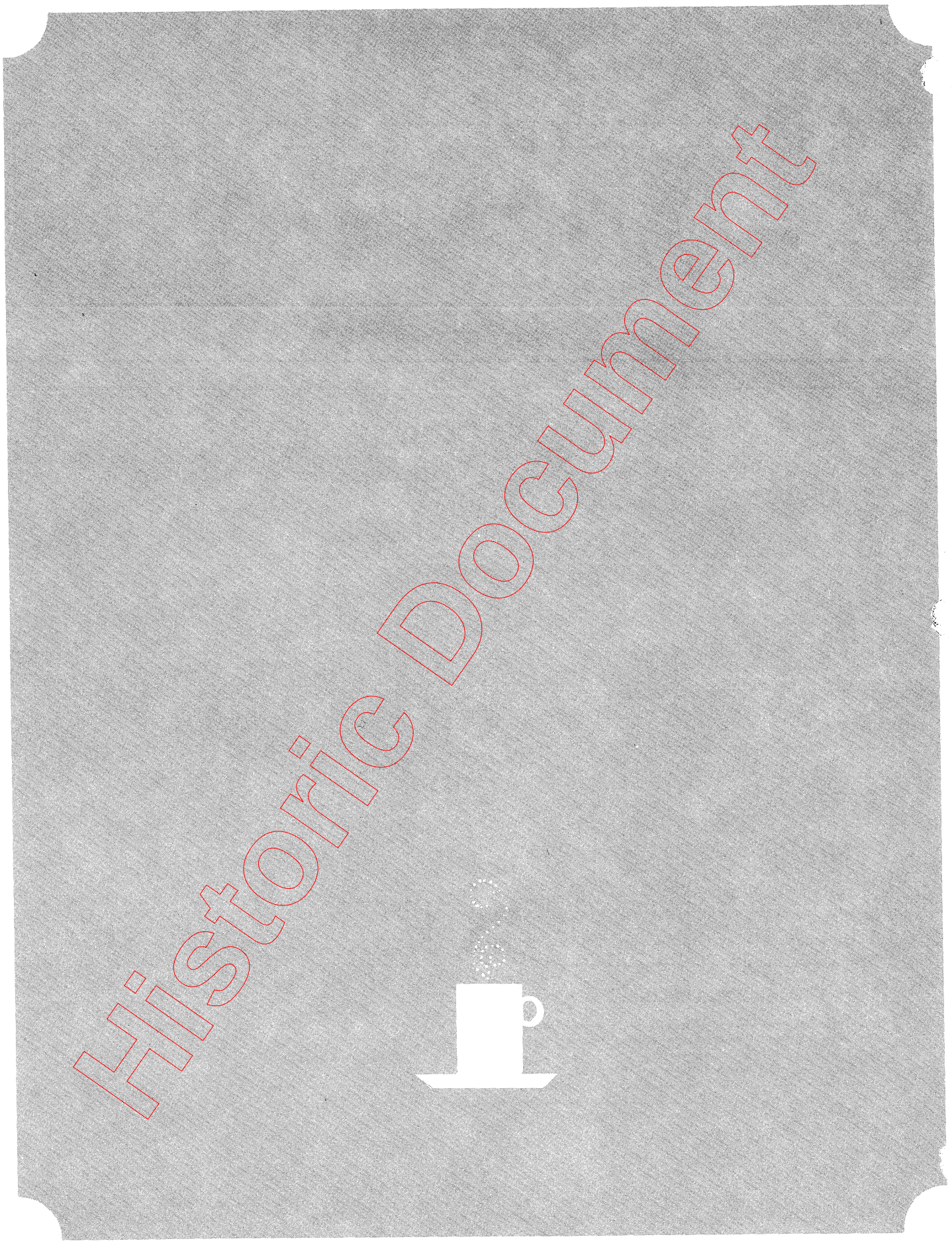
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